HIWRAP HS3 Status

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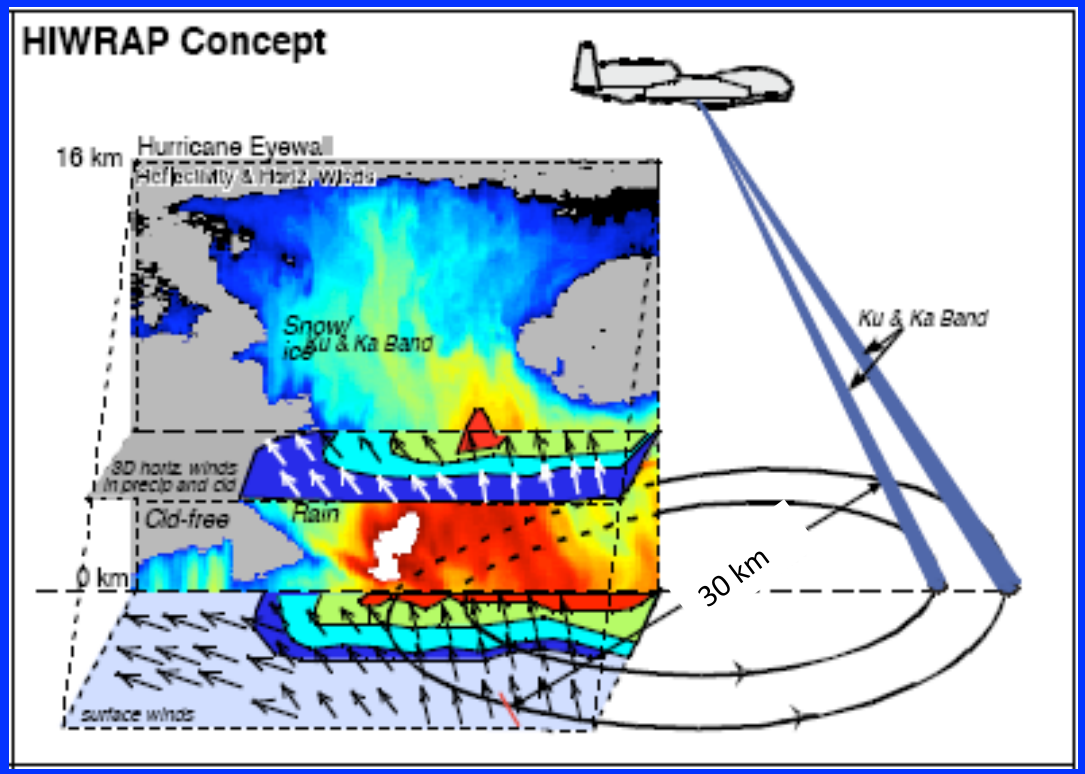
Remote Sensing SOLUTIONS

UMASS AMHERST CASCA

NASA

High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)



MEASUREMENTS GOALS:

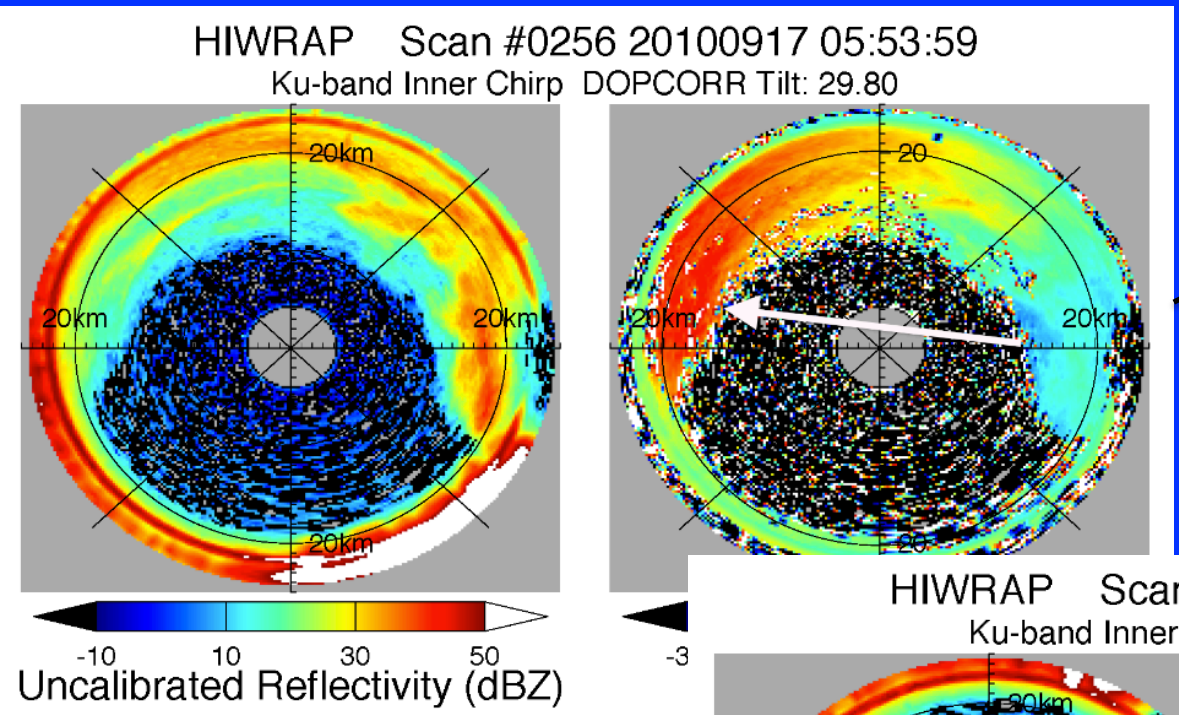
- ***Precipitation and 3-D winds***
- ***Ocean surface vector winds in clear to light rain regions***

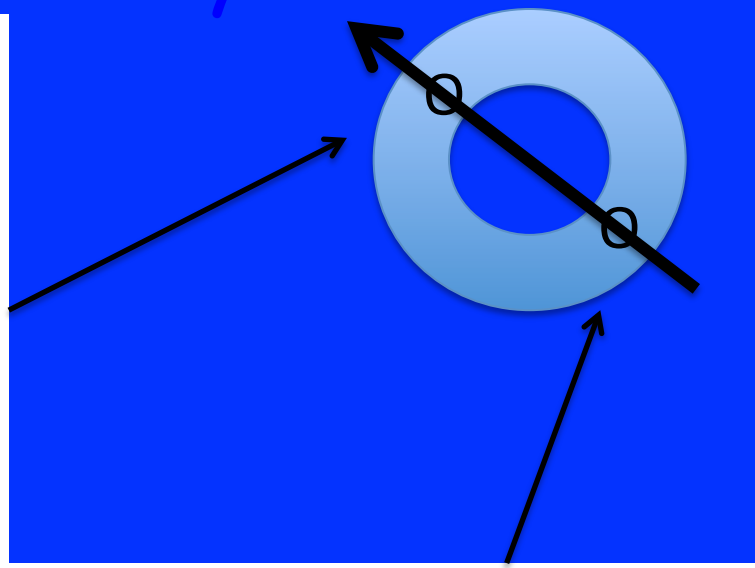
HIWRAP Characteristics:

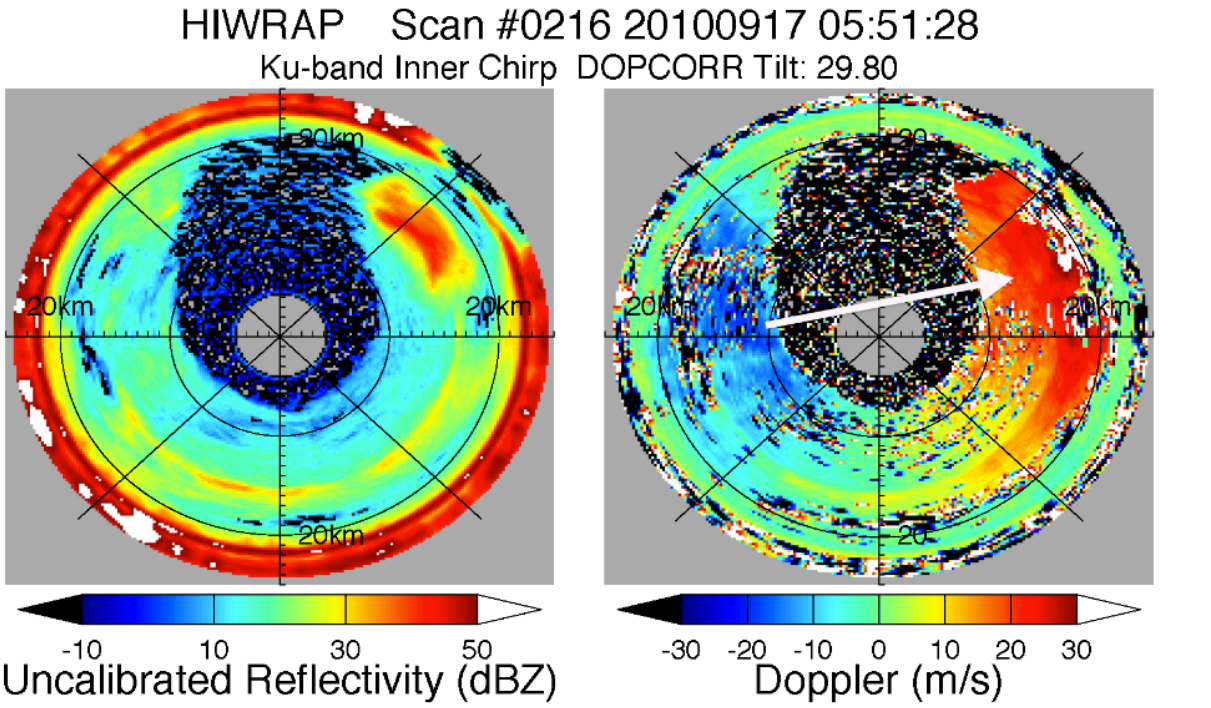
- **Conically scan**
- **Ku/Ka-band**
- **Two beams: 30 and 40 deg incidence.**
- **Fully solid-state radar**
- **GPM radar frequencies.**

HIWRAP System

Pass Across Karl's Eye



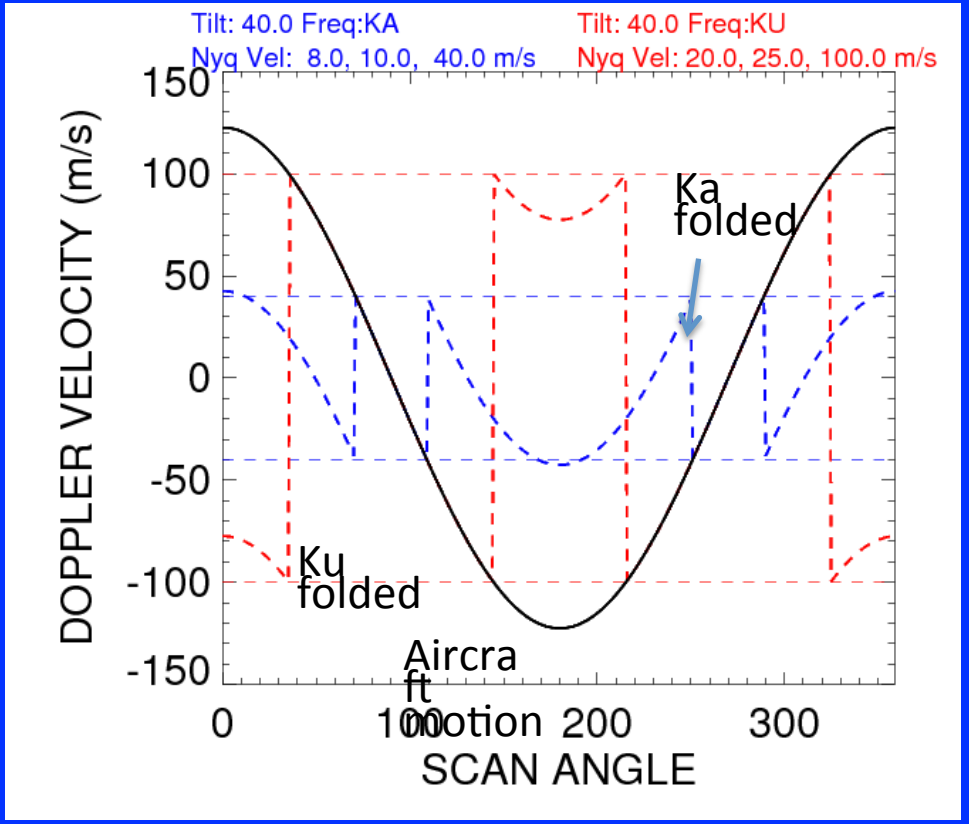




Doppler:
- Unfolded
- Corrected for aircraft motions

HIWRAP Doppler Unfolding

- Ku-band automated unfolding working reasonably well.
- Ka-band is more problematic because of low Nyquist velocity
- Tests are in progress to use Ku-band with higher Nyquist velocity to unfold Ka-band Doppler



PRF: 4000, 5000 Hz

Pulse-pair velocities: low PRF, high PRF, dual PRF

Ku: 20, 25, 100 m/s

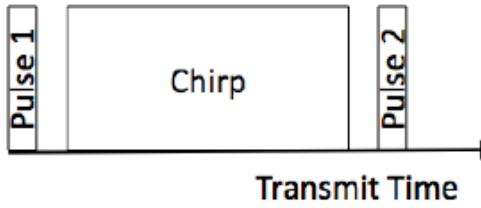
Ka: 8, 10, 40 m/s

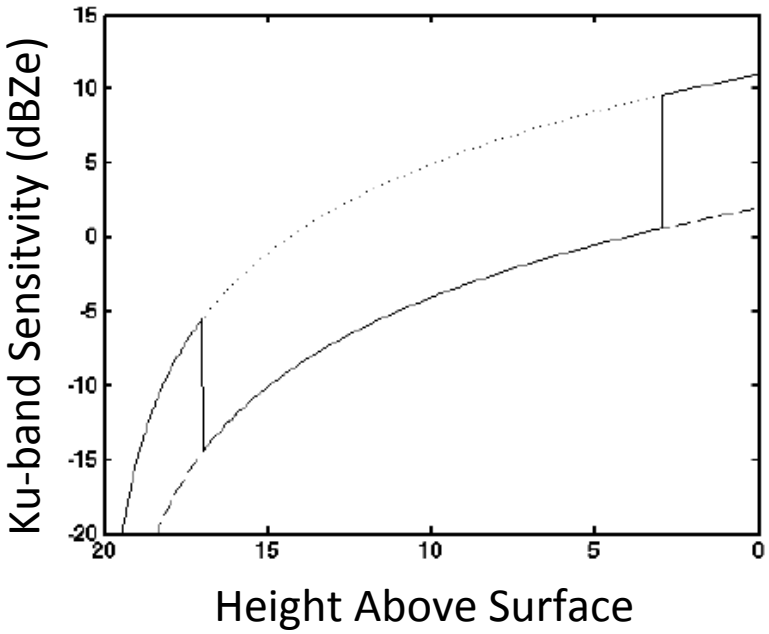
HIWRAP Current Instrument Status

- Radar hardware and software is under preparation for HS3 mission. There are no issues so far.
- Improvements since GRIP/MC3E
  - Improved sub-channel isolation by adjusting the sub-channel center frequencies in DDS waveform generation firmware.
  - Implemented a unique pulse and linear FM chirp waveform sequence for range sidelobe mitigation in the pulse compression channels.
  - Pulse compression and pulse pair processing firmware
  - New data system enclosure for better thermal and electrical performance
  - Battery backup for navigation system.
- Other:
  - HIWRAP Stage 4 (operational) license approved

HIWRAP Pulse Transmission for HS3

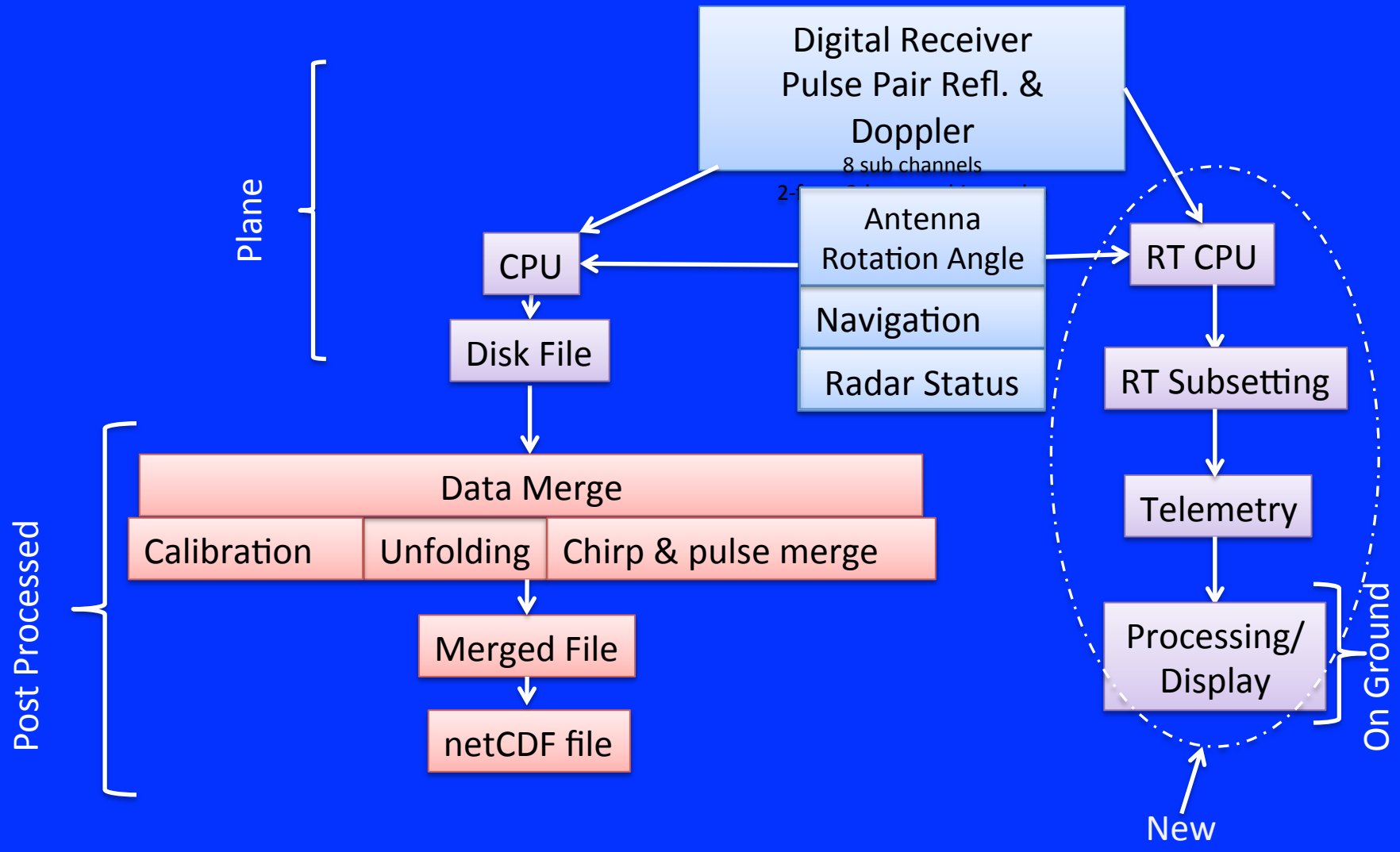
- Three pulses tranmitted: 2 μs, 20μs, 2 μs
  - First pulse: near surface returns
  - Second pulse: main chirp pulse, most sensitive channel, but range side lobes near surface
  - Third pulse for near aircraft returns in pulse compression blind zone





Example from MC3E so expected HS3 minimum reflectviity will be ~6 dB higher

HIWRAP Data Flow - HS3



Processing & Data

Instrument	Data Product	Description	**Preliminary** Latency Not to Exceed	**Final** Latency Not to Exceed
Doppler Radar	Level 1	Calibrated reflectivity, Doppler velocity	3 months	9 months
Doppler Radar	Level 2	Radial coordinate products including VAD, surface winds	6 months	9 months
Doppler Radar	Level 3	Gridded reflectivities, winds	6 months	9 months

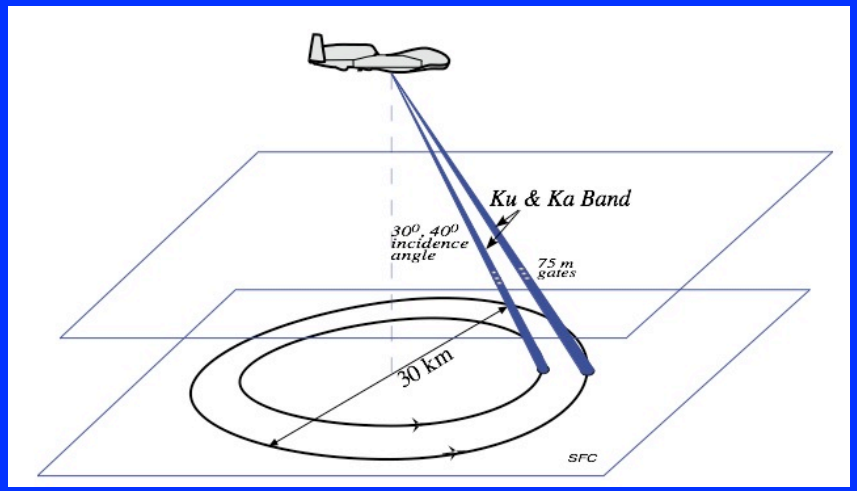
Notes

- 2012 HS3 flights will require software revision to accommodate pulse-pair processed data.
- Level 1: Data will be broken into 1 hour files; geolocation information will obtained with an IDL or Matlab routine applied to the netCDF Level 1 file.
- Level 3 (gridded) will be smoothed version of retrieval.
- Ocean surface winds still need a lot of work; calibration needs more work.

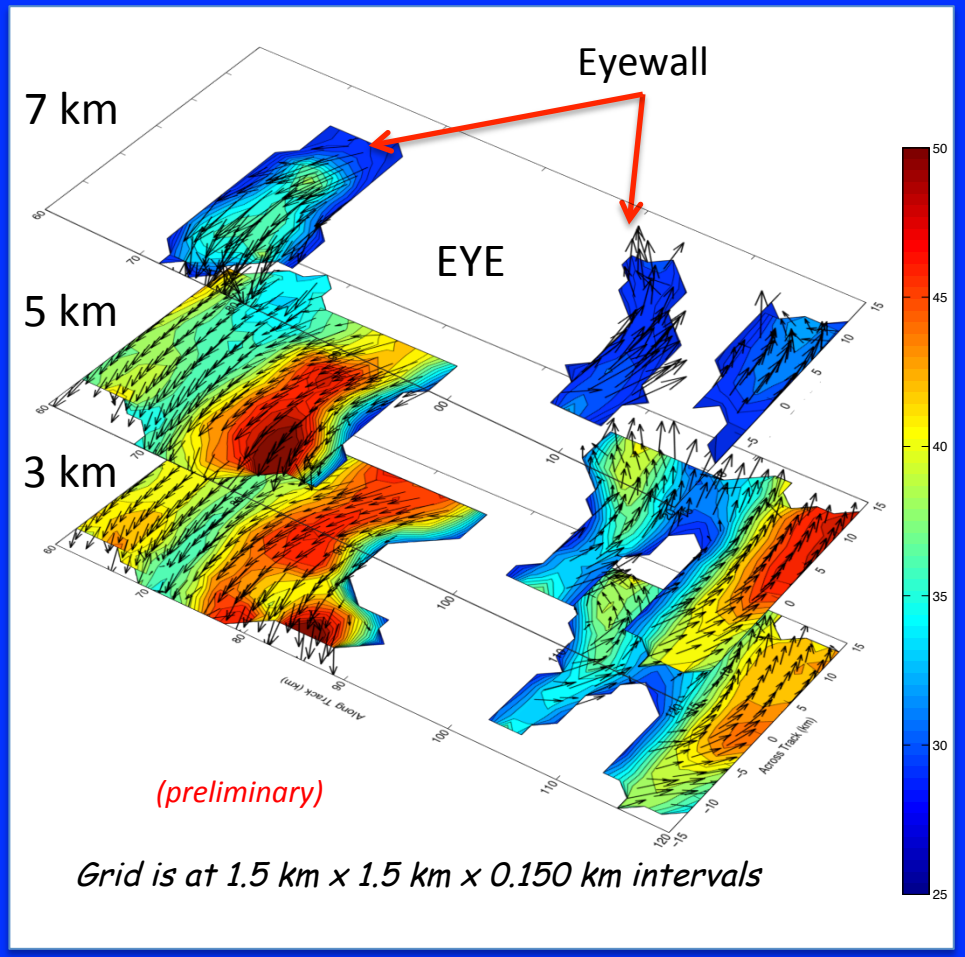
Retrieved Winds from Hurricane Karl (2010)

- HIWRAP made 20 crossings of Hurricane Karl on September 17, 2010 during GRIP over 14 hours.
- Doppler line of sight wind measurements are continually profiled during the conical scans.
- Horizontal winds are calculated from Doppler winds from multi look angles as the Global Hawk passes across the storm.

HIWRAP Measurement Geometry



Horizontal winds (m/s) and reflectivity (dBZ) derived from one pass across Hurricane Karl's eye/eyewall region



Courtesy S. Guimond/ONAU/GSFC

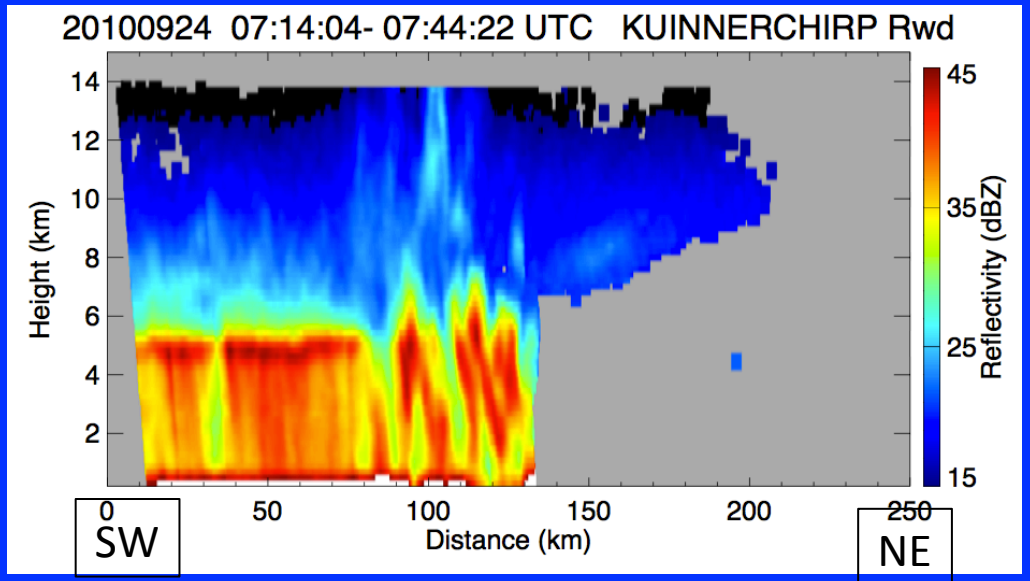
Planned Real Time Products

- Selected gates (e.g., 2, 4, 6 km) from one beam at each frequency -> Reflectivity and horizontal wind maps at specific altitudes
- Single profiles (0 or 180 deg azimuth) -> vertical cross section along GH track
- Selected gates around surface -> ocean winds, PBL winds

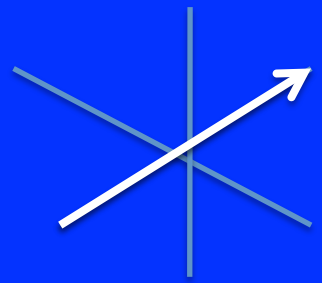
RT downlink in progress, not sure it will be ready for 2012 flights.

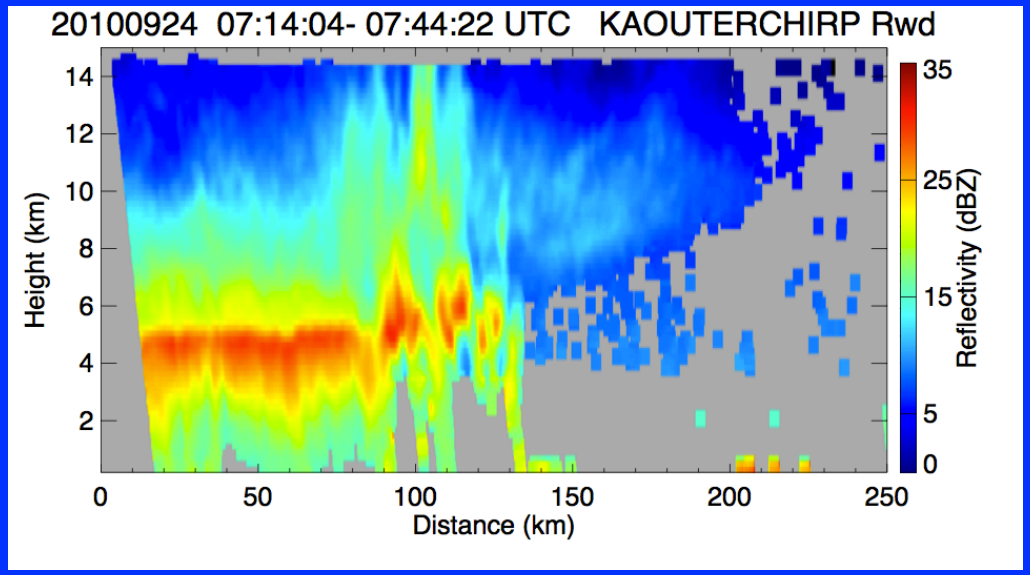
Any processing or mapping done on ground.

Sept 24 0714 - 0744UTC Reflectivity



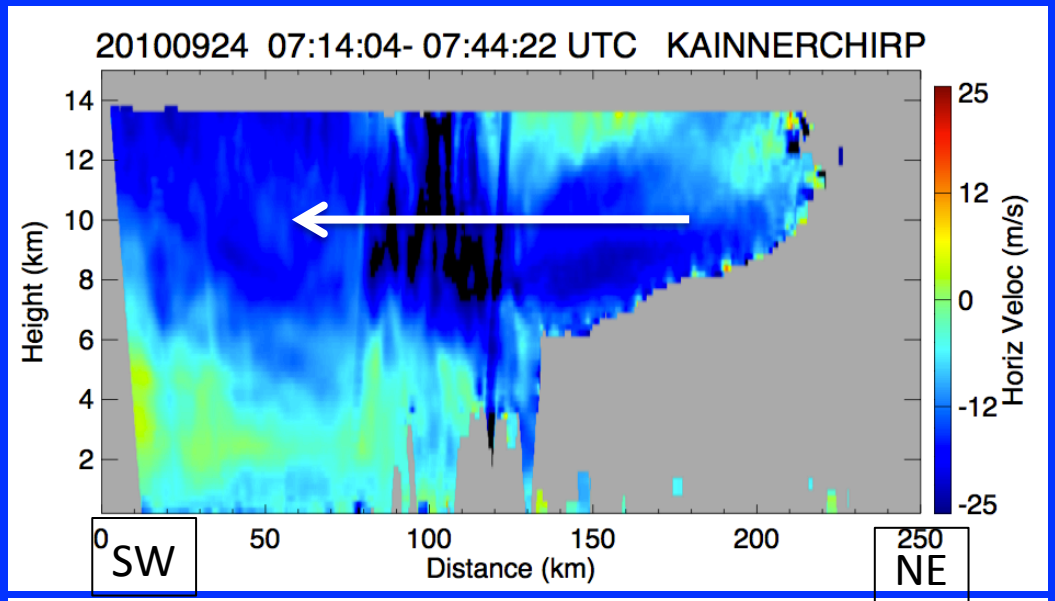
Ku-band
Inner Beam





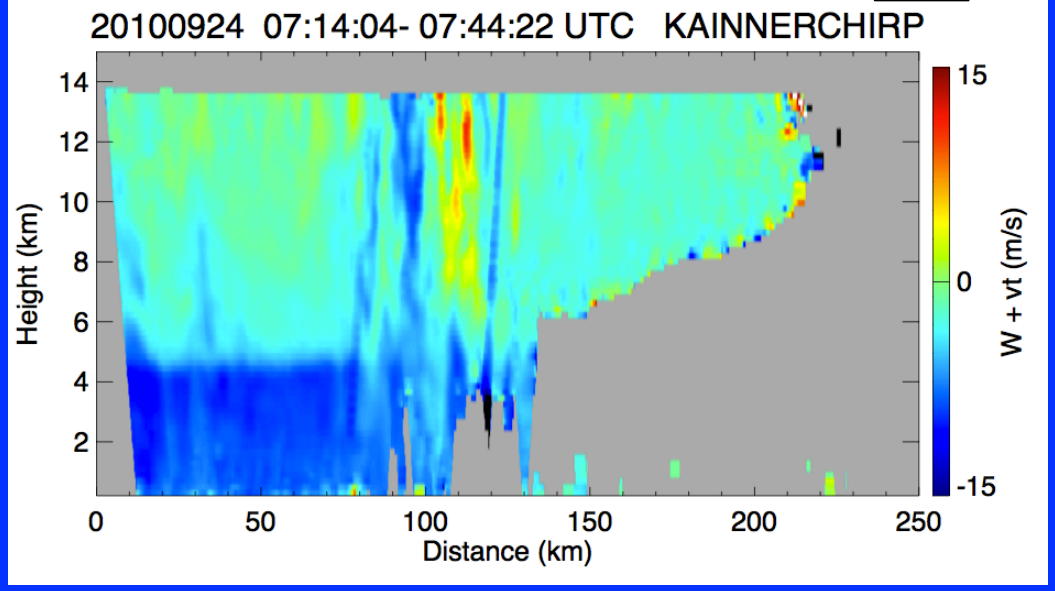
Ka-band
Inner Beam

Sept 24 0714 - 0744UTC



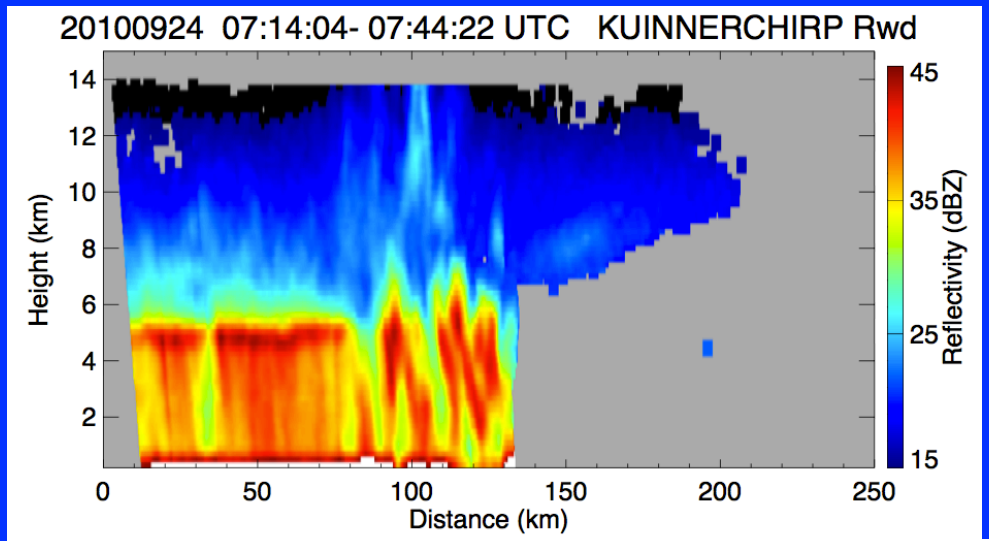
Ka-band
Horizontal Velocity

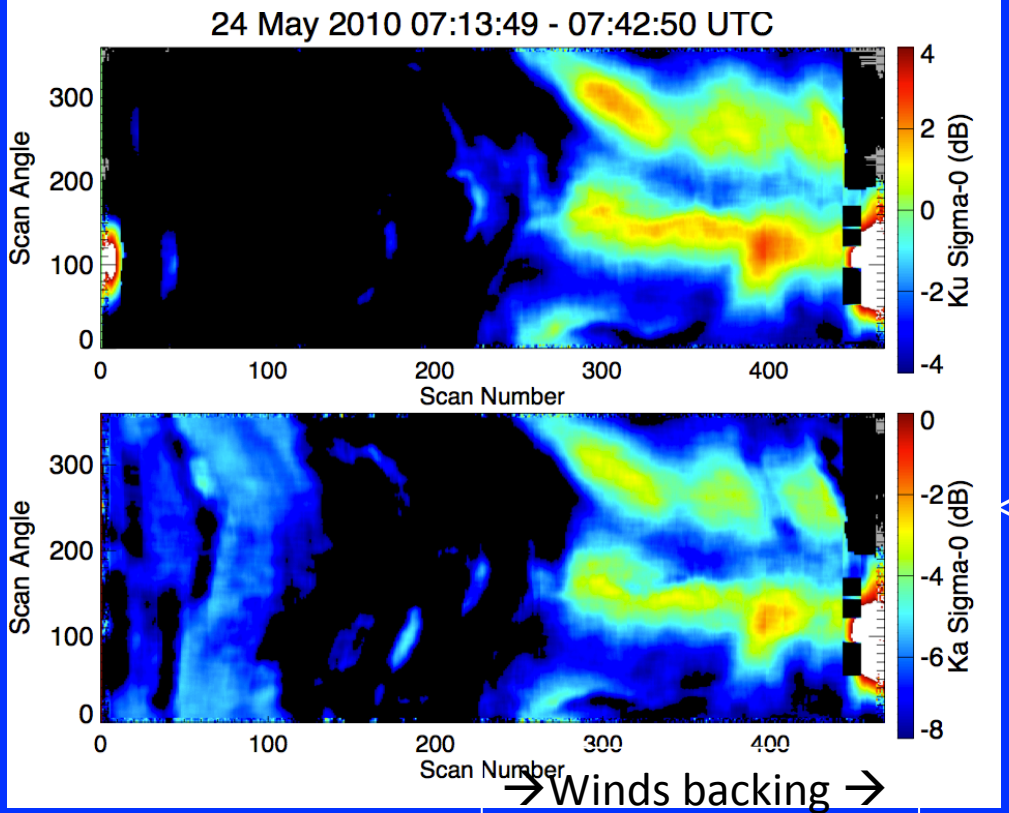
CIMMS cloud track 200 mb wind derived winds ~15 m/s toward W-SW. Shear ~15 m/s



Ka-band
W + vt
(hydrometeor motion)

Ocean Surface Winds

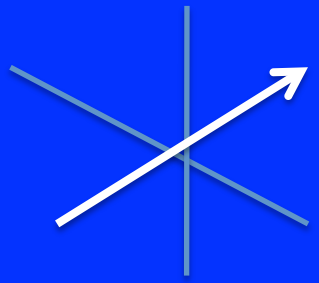




Still in preliminary stage but very promising.

How well can we see under clouds and remove rain/cloud ambiguities?

Normalized <- Radar Cross Section



Future Hardware Upgrades

- New IF up and down-conversion boards for better channel isolation.
- Amplitude modulation in FM chirp waveform for further pulse compression range side lobe reduction.
- Ka-band transceiver upgrade: improve sensitivity by 10dB by using a 40 W SSPA and low loss front-end components.

Summary

- Many improvements to radar hardware since GRIP in preparation for HS3.
- To be completed before HS3:
  - Digital receiver processing algorithm testing
  - New data system testing including multiple disk data storage
  - GPS battery backup
- Issues/Concerns
  - Digital receiver processing firmware testing
  - Solid state disk reliability

Questions?